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Judge not by numbers alone

The kernel of conventional wisdom, making its rounds in many defense circles and the attentive mass media, is that the United States has been standing still—even unilaterally disarming—in strategic forces for the past decade, while the Soviet Union has doggedly driven ahead.

At first glance, there seems to be some truth to this claim. Since 1969, the Soviets have deployed three new intercontinental ballistic missiles (ICBMs), all with multiple warheads (MIRVs), and three new submarine-launched ballistic missiles (SLBMs), one of them MIRVed. (The ICBMs are SS-17, SS-18 and SS-19; the SLBMs are SS-N-8, SS-N-17 and (MIRVed) SS-N-18. The Soviets have developed a light, single-warhead SS-16 ICBM, but have not deployed it.) During the same period, the United States has deployed only the Minuteman III ICBM, the Poseidon and (in very small quantities) Trident I SLBMs, and by the early 1990s faces a substantial attrition in the SLBM force, due to block obsolescence of Poseidon submarines only partially relieved by the introduction of new and larger Trident subs.

Furthermore, the CIA estimates that over the past decade the Soviets have spent about twice as much as the United States on offensive strategic nuclear forces, not including research and development funds.[1]

But have we really been standing still? And can this question be answered by examining such static indicators as the number of missiles, new missiles or missile throw-weight? Is cost necessarily proportional to effectiveness? Is the rejection of certain weapons, say the B-1 bomber, an act of unilateral restraint or strategic foresight? What qualitative improvements have we made in our strategic force, and how do these stack up—in terms of *force-effectiveness*—to the improvements made by the Soviets?

Missiles and warheads. Many of the "trend charts" designed to illustrate U.S. strategic restraint depict the number of strategic delivery vehicles (missile launchers and heavy bombers) held by each side over a period of time. Since 1969, the Soviet nuclear arsenal has grown from 1,514 delivery vehicles to 2,504—an increase of nearly 1,000. Meanwhile, the United States has reduced the number of its missiles and bombers from 2,270 to 2,058—a drop of more than 200.[2] At first glance, this "nose count" conveys a dismal tale.

However, looking at the number of strategic nuclear *weapons*—as opposed to the *platforms* that merely launch or drop them—the United States has enlarged its strategic arsenal from 3,950 in 1969 to more than 9,200 today, while the Soviets have grown from 1,659 to about 6,000.[3] In short, the United States force has risen by about 5,250, the Soviet by about 4,341. Thus the United States has substantially outpaced the Soviets in the number of newly deployed warheads. And as Henry Kissinger once noted, it is bombs and warheads, not delivery vehicles, that kill people and destroy military and industrial targets.

ICBMs and guidance systems. Two factors determine the effectiveness of a nuclear force: first, the number of warheads (how many targets the force can cover); second, the lethality of these warheads (with what probability the weapons can destroy particular targets).

It is true that the United States has not developed a single new ICBM since the 1970 Minuteman III. And that missile is a modification of the 1966 Minuteman II, which is in turn an upgrade of the 1962 Minuteman I, which is no longer in operation.

There are more ways to improve a force, however, than merely by building new missiles. For example, Minuteman III is basically the same as Minuteman II, except for its top stage; but in terms of effectiveness, it is certainly a new missile. The 1.2-megaton single warhead of the II was replaced on 550 Minuteman IIIs by a post-boost vehicle containing three MIRVs, each with far greater accuracy than the warhead on Minuteman II.

Since then, the inertial guidance on Minuteman III has been modified for still greater accuracy. This is significant, since the probability of destroying hardened (blast-resistant) targets is more strongly a function of accuracy than of explosive yield in this calculation.[4] This new guidance software has sharpened each warhead's average accuracy, or CEP (circular-error-probable), from 1,200 to nearly 600 feet.[5] This in turn has nearly tripled each warhead's chance of destroying very hardened Soviet ICBM silos, from 19 to 55 percent probability.[6]

During this time, the Soviets have added three entirely new ICBM sys-

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tems to their arsenal. Beginning in 1974 and continuing through today, the Soviets have replaced some of their SS-9s with SS-18s; starting in 1975, they have substituted some SS-11s with SS-17s and -19s. But in terms of added capability results per warhead have been about the same.

Total cost of the Minuteman III improved guidance program, according to Department of Defense figures, was $150 million—several orders of magnitude cheaper than building a new missile. Yet the improvement in force-effectiveness is comparable.

The near future will bring still greater lethality to the Minuteman III force. Over the next two years, the Mk-12 warheads on 300 of the Minuteman IIIs will be replaced by the Mk-12A. While adding just 35 pounds to the 2,000-pound throw-weight on Minuteman III, the Mk-12A will nearly double the explosive yield of each warhead, from 170 to 335 kilotons.[7] This $730 million conversion will improve hard-target-kill probability still further, from 55 to 70 percent.[8]

Finally, by the mid-1980s, guidance will probably be improved through further testing and refinement to reach its theoretical peak of accuracy—about 490 feet CEP.[9] With this improvement, those Minuteman IIIs with the older Mk-12 warheads will have a 70 percent chance of destroying Soviet missile silos in a single shot; those with the newer more powerful Mk-12A warheads will have an 83 percent chance.

At the same time, the Soviets will also be improving the accuracy of their guidance systems for the SS-18 Mod-4 and the SS-19 Mod-1-Variant ICBMs. Yet the improvement in force-effectiveness, warhead for warhead, will remain about the same: 83 percent chance of destroying U.S. missile silos with the SS-18 Mod-4 and 84 percent chance with the SS-19 Mod-1 Variant ICBMs.

The power of U.S. warheads has thus kept pace with the Soviet Union's, even without additional missiles. The new Soviet missiles, to be sure, have more warheads than the ones they replaced; and, thus, they can hit more targets. However, information from the CIA Military Economic Analysis Center shows the cost of these new missiles, through 1985, at $24.9 billion, or $5.8 million per additional hard target kill. The cost of the new U.S. guidance system upgrade and Mk-12A warheads amounts to a mere $880 million, or $900,000 per extra hard target kill. This means a cost-effectiveness ratio, between the United States and the Soviet Union, of 6.4:1. That is, our ICBM improvements have been more than six times as cost-effective as Soviet improvements (Table 1).

While the new guidance was being installed on Minuteman III, the United States also initiated a Silo Upgrade program that reduced the vulnerability of the entire Minuteman force. The program, completed last year, strengthened the blast resistance of Minuteman silos* from 300 to 2,000 pounds per square inch (psi) of transient atmospheric overpressure.[10] (The Titan IIs, however, remain at 300 psi, and there are no plans to upgrade them.) By the early-to-mid 1980s, as Soviet missile accuracy improves, these silos will once again be (theoretically) vulnerable. We have nearly reached the limits of silo hardness; additional upgrading would be very expensive and not very useful. However, implementing the Silo Upgrade program—at a total cost of $1.4 billion—delayed Minuteman vulnerability for at least six years, thereby mitigating the counterforce capabilities of the Soviet ICBM force.

In short, although we have built no new ICBMs since 1970 and no *totally* new ICBM since 1962, we have hardly been standing still over the past dec-

*An extra 10 inches of borated concrete was applied to the silo lids. The missiles were removed from their shock-absorbent springs and mounted on pendulum-like suspensions. Bins were installed to catch rubble when the silo cover is rolled back for missile launch. And titanium shrouds were placed on top of the missile cones, to resist the forces of electromagnetic pulse from high air-burst nuclear explosions, which could otherwise severely damage the missile's guidance and communications systems.

Table 1

Cost Comparison of American and Soviet ICBM Silo Kills[a]

	ICBMs	Warheads	Silo kills per warhead	Silos killed	Silos killed (B-A)	Cost of B ($ millions)	Cost per extra silo killed	Cost ratio USSR: U.S.
UNITED STATES								
A. Minuteman III	550	1,650	.19	314				
Total				314				
B. Minuteman III (1985)								
Improved guidance	250	750	.70	525				
Improved guidance + Mk-12A	300	900	.83	747				
Total				1,272	958	$880	$0.9	
SOVIET UNION[b]								
A. SS-9	308	308	.28	86				
SS-11	512	512	.07	36				
Total				122				
B. SS-18, Mod-4 (1985)	308	3,080	.83	2,556				
SS-19, Mod-1-Variant (1985)	312	1,872	.84	1,572				
SS-17	200	800	.34	272				
Total				4,400	4,278	$24,870	$5.8	6.4:1

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number of warheads, nearly tripled the ICBMs' effectiveness against the hardest of Soviet targets and reduced the counterforce power of Soviet ICBMs by more than 35 percent. Over the next two years, the counterforce capability of a significant portion of Minuteman missiles will be upgraded by another 20 percent and, in the two years thereafter, by 15 percent more.

The Soviets have spent tens of billions of dollars on new missiles, but we have continued to overwhelm them in deployment of new warheads; we have matched them in hard-target-kill capability with just a billion dollars worth of new guidance systems and warheads; and we have degraded Soviet missile power by upgrading our missile silos at low cost.

Bombers and cruise missiles. President Carter's decision on June 30, 1977 to cancel the B-1 bomber is infamous among those who believe the United States is declining in strategic strength. Many complain that we cancelled the B-1 and got nothing from the Russians in return.

These judgments are based on erroneous assumptions. Looking back at the statements made at the time, it is clear that the President based his decision on essentially one criterion: the air-launched cruise missile (ALCM) was more cost-effective than penetrating bombers. It had nothing to do with arms control or disarmament; nor was it a bargaining ploy with the Russians. As Carter said at the news conference dealing with his B-1 announcement: "I think if I had looked upon the B-1 as simply a bargaining chip for the Soviets, then my decision would have been to go ahead with the weapon." His simple reason for killing the program: "The B-1, a very expensive weapons system, basically conceived in the absence of the cruise missile factor, is not necessary."

Carter's decision looks even better today than it did two years ago. The Soviets have recently been developing a new surface-to-air missile, the SA-X-10, and an air-intercept missile with look-down/shoot-down radar, the AA-X-9, for the Mig-25 Foxbat fighter. Both could reportedly be ready for deployment in the early 1980s.[11] As William Perry, the Pentagon's chief scientist, testified last year before the Senate Armed Services Committee: "The B-1 depended for its penetration on high speed and low altitude. The air defense system that is being developed now in the Soviet Union, which includes look-down/shoot-down interceptors, would render that operation very hazardous."[12]

On the other hand, ALCMs, could penetrate to their targets with greater assurance. In their tests with look-down/shoot-down prototype radar, the Soviets have used target drones the size of an American T-33 aircraft, which has a radar cross-section of about 10 square meters.[13] By contrast, the ALCM has a radar cross-section of less than 0.05 square meters—1/200th that of the drone, 1/1000th that of a B-52, 1/100th that of a B-1—and it can fly lower than 100 feet off the ground, making it much more difficult to distinguish from ground clutter.[14]

In short, penetrating bombers are becoming increasingly vulnerable over Soviet airspace and the B-1 would not have improved the situation much. But ALCM goes far toward remedying the problem. Indeed, it virtually nullifies the enormous air-defense program on which the Soviets have spent 12 to 15 percent of their defense budget each year since 1970. Moreover, it forces them to spend another $30 to $50 billion over the next decade if they want to have a chance of shooting ALCM down.[15] If the Soviets do make such an investment, ALCM may become somewhat vulnerable by the late 1980s. At that point, however, very cheap, "matchbox"-sized electronic countermeasures (ECM)—the emission of only a few watts of power would elude or spook Soviet radar—will revive the cruise missile as an extremely tough target to track and shoot down.[16]

This is yet another illustration of the proposition that an expensive defense program does not necessarily produce greater defense capability than a cheap one.

At the same time, ALCM improves the bomber fleet's ability to destroy very hardened targets. Utilizing a terrain-contour-matching (TERCOM) guidance system, the missile can lay down 150 kilotons of explosive power within, theoretically, 100 feet of its target (though Kosta Tsipis suggests that operational degradations may reduce this to 300 feet). With this sort of accuracy, ALCM destroys virtually anything it is aimed at. In other words, the decision to go with cruise missiles rather than more penetrating bombers was armament."

Improvements have been made in the penetrators as well. The Air Force has spent more than $2 billion on major modifications of the B-52 over the past 20 years—in structural design, improved defensive electronics systems, better avionics and newer weapons. It is hardly the same weapons system that it was two decades ago. Top Strategic Air Command officials testify that the B-52s will be structurally sound through the late 1990s; the only trend affecting their capability is the pace of Soviet air defense.

This is where ALCMs come in; but even without them two U.S. programs increase the likelihood that bombers will be able to penetrate Soviet defenses, and that those that do will have a better chance of destroying their targets:

- The first of these is the short-range attack missile (SRAM), which began operation in 1972. Currently, a total of 1,250 are loaded onto some B-52Gs and B-52 Hs and on all of the FB-111 bombers. With a range of up to 150 miles, explosive yield of 170 kilotons, much smaller and about five times faster than cruise missiles, SRAMs are designed to knock out Soviet surface-to-air missile (SAM) batteries quickly so that the bomber can follow and penetrate relatively unthreatened (at least by missiles on the ground).[17] With proper tactics and timing, SRAMs can markedly improve the chances of a bomber's surviving.
- The second is the avionics modernization program, currently in development, scheduled for initial deployment in 1982 and to be fitted onto all the B-52Gs and B-52Hs by 1986. The program will improve navigational accuracy by more than 40 percent, double the overall system reliability from 0.4 to 0.8, and improve the bomber's defense electronics and jamming techniques for thwarting and confusing Soviet air defenses.[18]

In short, without producing a new bomber, and without considering the impact of SRAMs, the performance of B-52s against hard targets will greatly improve—simply due to the advanced avionics: 61 percent chance of destroying a Soviet missile silo *without* avionics modernization program; 97 percent chance *with* the program. Thus the decision to kill

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the B-1 was not an act of unilateral restraint, but rather a sagacious response to a developing Soviet air-defense threat and a simple, sensible recognition of new technological options for the United States.

The submarines: dwindling submarine-launched ballistic missiles? The problem here is one of block obsolescence. The last of the final 10 Polaris submarines will be retired in 1982. Poseidon submarines will start turning 25 years old—the normal retirement age for nuclear subs—in the late 1980s, and all will reach the quarter-century mark by 1992. At that point, given the planned production rate of Trident submarines, there will be only 384 submarine-launched ballistic missiles, down 41 percent from the 656 of today.

At first glance, this appears to constitute a grave attrition. But what matters more than the number of missiles is what they can do. It is useful here to explore what will happen to the U.S. SLBM force over the next 10 years.

Starting late in 1979 and continuing through 1982—in other words, coinciding with the Polaris phase-out—Trident I missiles are being retrofitted onto 12 of the 31 Poseidon submarines. Trident I has eight 100-kiloton warheads, as compared with Poseidon's nine 40-kiloton warheads—giving each missile about 63 percent greater equivalent megatonnage. Trident I is also more reliable, can be rapidly retargeted and can achieve the same accuracy at 4,000 nautical-mile range as the Poseidon can at 2,600. This added range relieves us of the necessity to operate nuclear missile subs from the naval base in Rota, Spain, and substantially reduces the possibility that some hypothetical Soviet breakthrough in antisubmarine warfare technology could endanger them. The added range expands the area of ocean from which our subs can operate by a factor of 10 to 20.[19]

The disappearance of the Polaris boats and the slight reduction of warheads do not seem to bother Defense Department officials. The big danger that many foresee arises in the late 1980s or early 1990s, when the entire Poseidon force may be phased out. The nadir will be reached in 1992. By that time, extrapolating from current production schedules, we could have 16 Trident subs, each with 24 launch tubes—in all, a capacity of 384 missiles. But the last four, those deployed in 1990-92, could be loaded with Trident II missiles. And unlike Trident each 150 kilotons, with sufficient accuracy to destroy the most hardened of targets, including ICBM silos.[20]

Nuclear strategists plan on the assumption of a worst-case, or worst-probable, threat. This assumed threat is a surprise attack by the Soviets, catching our forces on normal alert, with no time to generate more subs out to sea and more bombers into the air. It is useful, therefore, to compare near future and longer-term future forces on the basis of how many would survive on a normal alert, and what those surviving forces could do.

The smaller force of 520 submarine missiles projected for 1982 could destroy a larger number of reinforced industrial targets (at 10 psi) than the present force of 656 SLBMs (4,101 targets versus 4,078).

Again, assuming that the Soviets catch our submarines on normal alert, the still smaller arsenal of 384 Trident SLBMs in 1992 could destroy more targets than the 1982 force (2,376 targets versus 2,255). This is due in part to the improved yield and accuracy of the mixed force of the early 1990s, and in part to the higher percentage of Trident subs, as compared with Poseidons, that can remain on station at any one time—66 percent versus 55 percent.

This assessment, furthermore, underestimates the capabilities of the 1992 force, because planners may want to use SLBMs to strike targets much harder than those postulated here. For example, suppose that the SLBMs are required to destroy industrial targets of much harder reinforcement—say, 100 instead of 10 pounds per square inch. Even with far fewer warheads the Trident I/II force can destroy more targets than the Poseidon/Trident I mix—1,966 as against 1,593 (see Table 2). If missile silos (2,500 pounds per square inch or greater) were among the targets, *only* the 1992 force would produce significant results.

Finally, even these figures understate the power of the force because it is very unlikely that all Poseidon submarines will actually be retired by 1992. The 25-year lifespan of submarines is merely a "planning factor"; as with aircraft carriers, their life can be extended through relatively inexpensive methods.

In sum, the period of "decline" in the SLBM force most feared—the late 1980s and early 1990s—turns out, in fact, to be a period of resurgence in its overall force-effectiveness against hardened targets.

Whether all the strategic programs and "improvements" discussed in issue here. Deterrence, strategy and force-effectiveness obviously must be linked to requirements concerning the targets that must be destroyed, how much destruction is "enough," and what levels of confidence in their destruction are sufficient. For example, if it were judged that destroying urban centers, or most industrial facilities, or most non-silo military targets were "enough," there would be no need for many of the new developments that the United States has undertaken in ICBM, bomber or submarine technology. Accuracy is not particularly important for these sorts of missions, nor are weapons of much higher yield than those on presently deployed systems.

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If reinforced industrial and conventional military facilities were the sole targets of our strategy, the Minuteman III guidance upgrade, the Mk-12A warhead, and some of the offensive avionics improvements on the B-52 bombers would be superfluous. It is quite clear, however, that the Pentagon emphasizes increasingly these days—or at least with increasing candor—that destroying hard targets, particularly those of military value, is crucial to strategic planning. There is much that is questionable about such a targeting strategy, but, for this analysis, the assumptions of DOD planners have been adopted.

The point is that, in terms of the Defense Department's own assumptions and requirements, the United States has been advancing in a rather dramatic way over the past decade; that we have been doing so as much as the Soviets have and far more cheaply; that, contrary to many doomsayers, we are not engaging in "unilateral restraint" or "unilateral disarmament." We are not standing still.

1. CIA, *A Dollar Cost Comparison of Soviet and U.S. Defense Activities, 1968–1978* (Jan. 1979), pp. 5–7.

2. *The Military Balance, 1979–1980* (London: International Institute for Strategic Studies, 1979), pp. 88–89; *SALT II Agreement* (Memorandum of Understanding . . . Regarding the Establishment of a Data Base on the Numbers of Strategic Offensive Arms), June 18, 1979.

3. Harold Brown, DOD, *Annual Report, FY 1981*, p. 77; and derived from *SALT II Agreement* (Memorandum . . .).

4. Kosta Tsipis, *Offensive Missiles* (Stockholm International Peace Research Institute, 1974), p. 16.

5. "New Lease of Life for Minuteman," *Flight International*, Sept. 9, 1978; Justin Galen, "The Party Line," *Armed Forces Journal International*, June 1979, p. 36; House Armed Services Committee, Authorization Hearings, FY 1979, Pt. 3, Bk. 1, p. 307.

6. Calculated on D. C. Kephart, *Damage Probability Computer for Point Targets with P and Q Vulnerability Numbers* (Santa Monica: RAND Corp., February 1974), and Dr. Kephart's "VNTK Adjustment Monograph for P-type Targets," provided by author.

7. "New Lease of Life for Minuteman;" p. 307; Senate Armed Services Committee, Authorization Hearings, FY 1979, Pt. 9, p. 6541.

8. Cost of Mk-12A calculated as follows: DOD costs for the re-entry vehicle (RV) are $504 million (obtained from DOD). Cost of RDT&E on warhead is $136 million (obtained from DOE). Total cost in MX program of construction design and DOE warhead are $1.4 billion (GAO, *Indecision and Uncertainty Exist in the Development of an Advanced ICBM Weapon System*, Feb. 8, 1979, p. 45 [unclassified page]); cost of construction design is $600 million (DOD); therefore, cost of warhead is the difference, $800 million. This is for the 2,000 warheads of the MX plan. Cost of 900 warheads for Minuteman III must, therefore, be $360 million. Add to this RDT&E and one-third the cost of the RVs (since Minuteman III will take one-third the cost of the Mk-12A's produced); add 10 percent for inflation (to get FY1980 dollar value); and this brings the total cost to $730 million. Kill-probability calculated on Kephart.

9. Clarence Robinson, "MX Basing Delay Threatens SALT Ratification," *Aviation Week & Space Technology* (Nov. 20, 1978), p. 22.

10. "New Lease of Life for Minuteman", Pt. 9, p. 6541; House Armed Services Committee, Pt. 3, Bk. 1, pp. 307, 853–56; "MX Deployment Urged for Parity," *Aviation Week & Space Technology* (Dec. 5, 1977), p. 13.

11. Clarence Robinson, "Soviet Developing 2 Bombers, Extending Range of Backfire," *Aviation Week & Space Technology* (Feb. 19, 1979), p. 15.

12. Senate Armed Services Committee, Authorization Hearings, FY 1980, Pt. 1, p. 364.

13. Fn. 20: Coleman Rogers, "B-52 Role Facing Change: Cruise Missile Test Results," *Military Electronics/Countermeasures* (Feb. 1979), p. 106.

14. Senate Armed Services Committee, Authorization Hearings, FY 1979, Pt. 1, p. 306; "Perry Confirms Soviet Look-Down Tests," *Aviation Week & Space Technology* (Jan. 1, 1979); Kosta Tsipis, "Cruise Missiles," *Scientific American* (Feb. 1977); and information from Air Force.

15. Dr. William Perry, quoted in Philip Klass, "Pentagon Analyzes Test of Tomahawk," *Aviation Week & Space Technology* (Nov. 20, 1978), p. 24.

16. Dr. William Perry, Senate Armed Services Committee, Authorization Hearings, FY 1980, Pt. 1, p. 398; Perry quoted in Philip Klass, "Pentagon Analyzes Test of Tomahawk," Aviation Week & Space Technology (Nov. 20, 1978), p. 24.

17. Robert T. Petty, ed., *Jane's Weapon Systems, 1976* (NY: Franklin Watts, 1976), pp. 147–48; Alton H. Quanbeck and Archie L. Wood, *Modernizing the Strategic Bomber Force* (Washington, DC: Brookings Institution, 1976), p. 30.

18. Senate Armed Services Committee, Authorization Hearings, FY 1979, Pt. 9, pp. 6820–22; House Armed Services Committee, Pt. 3, Bk. 1, p. 275; Benjamin M. Elson, "Bomb/Nav Changes Key to B-52 Update," *Aviation Week & Space Technology* (Aug. 14, 1978), pp. 60–65; Robert M. Kochis, "New Missions, New Updates for B-52," *Electronic Warfare/Defense Electronics* (April 1979), pp. 45–49.

19. Congressional Budget Office, *Retaliatory Issues for the US Strategic Nuclear Force* (June 1978), pp. 6–7; Clarence Robinson, "New Propellant Evaluated for Trident Second Stage," *Aviation Week & Space Technology* (Oct. 13, 1975); Senate Armed Services Committee, Pt. 2, p. 1030; Justin Galen, p. 36; Senate Armed Services Committee, Authorization Hearings, FY 1980, Pt. 1, p. 6682.

20. Senate Armed Services Committee, Authorization Hearings, FY 1979, Pt. 2, p. 1037 and Pt. 9, p. 6706; FY 1980, Pt. 1, pp. 329–30; Robinson, p. 16; Harold Brown, DOD *Annual Report, FY 1979*, p. 114.

21. Senate Armed Services Committee, Authorization Hearings, FY 1980, Pt. 1, p. 327.

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